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PRELIMINARY TEST SPECIFICATION
FOR STRAIN GAGES
TO BE IRRADIATED AT THE PLUM BROOK REACTOR
23/W408

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PRELIMINARY TEST SPECIFICATION FOR STRAIN GAGES
TO BE IRRADIATED AT THE PLUM BROOK REACTOR 23/W408

I. EXPERIMENT IDENTIFICATION

A. Test Plan Reference No.	23/W408
B. Sponsor	WANL
C. Testing Agency	PBRF
D. Test Date	September, 1965

II. PURPOSE OF THE EXPERIMENT

This experiment is designed to evaluate the performance of foil gages bonded with inorganic cement in a nuclear radiation environment. In addition, Microdot weldable gages will be irradiated in order to define further the nature and cause of the zero shift observed during the July, 1964, PBRF test (23/W406).

There will be 4 pairs of Budd "C" series gages bonded with "H" ceramic cement and six active-dummy Microdot weldable gages. Of the six weldable gages, four will be welded to constant strain beams for dynamic actuation while the other two will be welded to an unstrained member of the fixture.

The test items will be operated at the maximum radiation levels for 28 hours. This is intended to provide performance data with respect to the integrated fast neutron flux that would be encountered in a one-hour, full power NRX test.

The data obtained in this test will be used to predict the performance of the strain gages when subjected to NRX environmental conditions.

III. DRAWINGS

A. Test Item	To be supplied with the Final Test Specification
B. Pneumatic	To be supplied with the Final Test Specification

C.	Hydraulic Single Line	Not Applicable
D.	Electrical Single Line	To be supplied with the Final Test Specification
E.	Dosimeters	WANL Drawing No. 387D5I9

IV. EQUIPMENT LIST

- A. To be provided by WANL Instrumentation Laboratory.
  - 1. Test Fixture including the following materials:
    - a. Six constant strain beams with strain gages attached.
    - b. Four copper-constantan thermocouples.
    - c. All required signal and control leads.
  - 2. Instrumentation console containing the following equipment.
    - a. BLH strain indicator type 120.
    - b. D-C Accu Data III amplifier Model DISA-1003.
    - c. Three 6-volt wet cell batteries Gould Type 3C5I3.
    - d. Control panel with voltage regulator and strain gage switching and balancing circuit.
  - 3. General Radio type 1862-C megohmmeter
- B. To be provided by WANL, PBRF.
  - 1. One EI digital multimeter type 883
  - 2. One oscilloscope, Tektronix Type 516
- C. To be provided by NASA Plum Brook.
  - 1. Eleven channels of the data logging system.

V. TEST ENVIRONMENT

A.	Temperature	125°F (nominal ambient water temperature)
B.	Pressure	135 psi External (nominal inlet water pressure)

C.	Humidity	Fixture submerged in the coolant water
D.	Vibration	None
E.	Fast Neutron Flux*	$5.1 \times 10^{13} \text{ n/cm}^2\text{-sec (E > 1.0 mev)}$
F.	Thermal Neutron Flux*	$4.3 \times 10^{14} \text{ n/cm}^2\text{-sec (E < 0.48 ev)}$
G.	Gamma Flux*	$1.9 \times 10^{11} \text{ ergs/gm(C)-hr}$
H.	Integrated Fluxes	
	Neutron Fast**	$2.2 \times 10^{18} \text{ n/cm}^2 \text{ (E > 1.0 mev)}$
	Neutron Thermal**	$1.6 \times 10^{19} \text{ n/cm}^2 \text{ (E < 0.48 ev)}$
	Gamma**	$2.7 \times 10^{12} \text{ ergs/gm(C)}$
I.	Fluid Environment	Water
J.	Duration	28 hours

VI. ANALYTICAL

Analysis of the heating rate and radioisotope inventory will be supplied in the Final Test Specification.

VII. FACILITY REQUIREMENTS

A.	Electrical	115 V AC, 60 cps
B.	Pneumatic	Reactor Off-Gas System
C.	Hydraulic	Primary Coolant Water
D.	Special Fluids	None
E.	Special Shielding	None

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*Maximum values for the strain gages closest to the reactor core.

**Integrated fluxes for the gages located at the bottom of the fixture (90° from the core side). The fluxes at this location were selected for determining the total test duration. In this way, we do not greatly over-expose the gages closest to the core or greatly under-expose the gages furthest from the core.

VIII. DOSIMETRY

Four neutron dosimeters shown by WANL drawing 387D5I9 will be mounted in the test fixture. The dosimeters will include aluminum-cobalt wires, bare and cadmium covered for thermal and epithermal flux measurements, and sulfur for fast flux measurements.

IX. DATA HANDLING REQUIREMENTS

Test data shall be read and manually recorded by WANL personnel. In addition, eleven data channels consisting of the d-c excitation voltage, and ten strain gage outputs, shall be paralleled to the Plum Brook data logging system.

X. TEST PROCEDURE

A. System Description

I. Test Specimens

The specimens to be irradiated will be installed in a test fixture on constant strain beams that are deflected against a fixed stop when helium gas pressure is supplied to the bellows in the fixture.

Gages to be utilized in the test are as follows:

- a. 8 unbacked foil gages manufactured by Budd. These are the "C" series gages and will be bonded with "H" ceramic cement.
- b. 6 Microdot active-dummy weldable gages Model SG-323/I (IDB Sr-30).

The foil gages will be connected in half bridge configurations. Each half bridge will be provided with a 15-foot long stainless steel sheathed, 3-conductor, MgO insulated cable.

2. Pneumatic System

The purpose of this system is to provide a helium supply to the bellows in the fixture, which in turn will deflect the test beams and thus apply a known strain to each

strain gage. The pneumatic exhaust line will be connected to the presently existing PBRF off-gas system.

3. Data Acquisition System

The strain gage measuring system will consist of the following units.

- a. A Baldwin-Lima-Hamilton strain indicator, Type 120. This unit is a carrier type amplifier with a manually balanced null indicator. It has a gage excitation of 3 volt rms at 1000 cps.
- b. A d-c readout with a gage excitation of 10 volts d-c will be utilized to simulate the data acquisition system at NRDS. The d-c output will be read from an EI type 883 digital multimeter and at the same time will be recorded on the data logger.
- c. The General Radio Megohmmeter type 1862-C will be utilized to measure insulation resistances.
- d. The EI type 883 multimeter will be utilized to measure continuity and gage resistances.

B. Laboratory Tests

1. With the test specimens installed in the test fixture, adjust the zero preload stop to about 200 μ in./in. Next activate the bellows with the helium gas supply and adjust the full load stop to about 1000 μ in./in.
2. Measure the resistance of the gages with a multimeter.
3. Measure the insulation resistance of the gages with a megohmmeter.
4. Measure the gage output with the carrier system and then with the d-c system. This measurement should be performed under no load and full load.

C. WANL Water Loop Test Procedure

Install the test fixture in the WANL water loop, make cable and pneumatic tube connections, and repeat the series of tests described in section B.

D. Pre-Irradiation Test Procedure

Repeat procedure described in paragraph C above with the fixture installed in the PBRF test capsule.

E. Irradiation Test Procedure

Before inserting the fixture, put all equipment in operating condition. Check helium gas supply and assure sufficient quantity to maintain pressure as required during test.

The fixture shall then be inserted in fixed increments by the charging machine. The exact insertion steps will be given in the Final Test Specification. Repeat the tests in section B noting and recording zero shift, insulation degradation and sensitivity variation in all of the strain gages for each insertion step. After the fixture has reached the reactor core centerline, the tests will be repeated at two-hour intervals for the entire 28-hour test duration.

F. Post-Irradiation Procedure

1. Measurements

Repeat all measurements described in section B two times after the test fixture has been moved from HT-I to the quadrant water.

2. Hot Cell Examination

After completion of the post-irradiation measurements, the fixture shall be placed in dry storage until it can be transported to a PBRF hot cell. In the hot cell, a complete examination (including photographs) shall be made of each strain gage noting particularly any signs of cement cracking or crazing. Electrical measurements shall be made at the discretion of the cognizant test engineer.

XI. HAZARDS

A complete evaluation of hazards will be made in the Design Manual and Hazards Report which will be issued prior to the irradiation.

XII. DATA REDUCTION REQUIRED

It is requested that the eleven channels of data acquired by the Plum Brook Automatic Data Logger be reduced to tabular form and then be made available to WANL. The requirements for analog plots of the experimental data will be coordinated with the Radiation Effects Programs Department.

XIII. DISPOSITION OF HARDWARE

A. Test Item

Hold test fixture and test specimens in dry storage at PBRF for post-irradiation examination.

B. WANL Supplied Test Equipment

Return test equipment supplied by WANL, Large upon conclusion of hot cell tests.

XIV. SHIPPING INSTRUCTIONS

Ship the test item and test equipment to A. Stephens, Plum Brook. Return the test equipment to Dave Kraykovic, Large.